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ABSTRACT

The final report and addendum document a 2-year study which examined the efficacy of a rhythmic training program to improve rhythmic skill in children with mild mental retardation or learning disabilities (year 1) or hearing impairments (year 2). The study was based on the writings of the Soviet neuropsychologist A. R. Luria suggesting the value of improving rhythmicity skills in disabled individuals. During the first year of the study 268 learning disabled and educable mentally retarded children between the ages of 7 and 10 participated, while during the second year participants were 43 children between the ages of 9 and 14 from the Tennessee School for the Deaf. Results indicated the treatment groups performed significantly better than the control groups on the rhythmic testing protocol. Both treatment and control groups were found to improve significantly in response to tactile stimuli rather than visual stimuli. (DB)

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AN INTERDISCIPLINARY APPROACH TO TRAINING THE ARRHYTHMIC CHILD

by
Wendell Liemohn, Ph.D.
School of HPER
College of Education
The University of Tennessee
Knoxville

Final Project Report, September, 1985

This project was funded by the Office of Special Education and Rehabilitative Services, Department of Education, Grant No. G008300016. However, contents do not necessarily represent the policy of that agency and you should not assume endorsement by the Federal Government.

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AN INTERDISCIPLINARY APPROACH TO TRAINING THE ARRHYTHMIC CHILD

(ADDENDUM TO FINAL PROJECT REPORT)

by
Wendell Liemohn, Ph.D.
School of HPER
College of Education
The University of Tennessee
Knoxville

Final Project Report (dtd September, 1985, Addendum dtd January, 1986)

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Preface

In the summer of 1983, the University of Tennessee at Knoxville was the recipient of a grant from the Office of Special Education, Department of Education, Washington,D.C. The major thrust of the project in Year ONE was to determine if a rhythmicty training program could improve the rhythmicity skills of learning disabled and educable mentally retarded children. In Year TWO the population receiving the rhythmicity training were hearing impaired children. The genesis of the idea for this investigation was based on writings of the Soviet neuropsychologist Luria. Luria believed that rhythmicity skills could be improved in individuals sustaining neurologic trauma; however, his contention was based on case studies and had not been tested using more conventional statistical procedures.

During the first year of this research project (1983-84), the students participating in the rhythmicity training activities were 268 learning disabled and educably mentally retarded children between the ages of 7 and 10 from the Knoxville City, Knox County and Anderson County school systems. During the second year of this project (1984-85), the students participating in the rhythmicity training activities were children between the ages of 9 and 14 from Tennessee School for the Deaf.

This report consists of (a) an introduction which provides the theoretical basis for the research, (b) the methods and procedures followed in this investigation including a description of the training activities, (c) the research findings.

ACKNOWLEDGEMENTS

Dr. Richard Yoakley, Personnel Director, Knox County Schools, his support staff including Dr. Mary Carrol, Ms. Susan Bolt and Dr. Jenice Yoder, were also most helpful. In the Knoxville City Schools, Dr. Roberta Werner, Director of Special Education, was most supportive. Mr. Steve Brody, Director, Daniel Arthur Center, Oak Ridge, and also Director of Special Education, Anderson County Schools, was most helpful in facilitating our initial testing efforts in the public schools during the first year of the project. Likewise the support of Dr. Sam Bratton, Supervisor, Research and Evaluation, Knox County Schools and Dr. John McCook, Director of Research, Knoxville City Schools, was most appreciated. Thanks are extended to the 19 principals who made their schools available for this project for the initial testing. The training and control programs were then conducted in 16 of these schools; particular thanks are extended to these principals and their special education and resource room teachers, who adjusted their schedules to fit the design of the project. The 268 children who participated in the original testing and the 120 who participated in the experimental and control programs and completed all post and retesting, were obviously most important too.

Elementary Principals:

Ron Harper, Beaumont
Lula Powell, Green
Donna Parrot, Oakdale
Harold Smith, Lonsdale
Cathy Summa, Knoxville Adaptive Education Center
Myles Hicks, Fair Garden
Scott Haynes, Halls
Fred West, Powell
David Wetzel, East Knox County
Dr. Ray Ross, Copper Ridge
William Thomas, Sunnyview
John McCloud, Brickey
Ralph Beeler, Flenniken
Ben Burnett, Karns Primary
Fred Russel, Karns Intermediate
Frank Bowden, Sarah Moore Greene
Tony Earl, Daniel Arthur Center
Carl Etter, Eastport
Della Oliver, Maynard

Resource Room/Special Education Teachers

Nancy Ware	Delores Jones
Karen Young	Jana Neff
Jane Madison	Ann Collins
Barbara Wilson	Bonnie Douglas
Debra Thompson	Janet Chesney
Laura Wasneechak	Cynthia Coffman
Karen Metcalf	Naomi Filmore
Cynthia Zachary	LuAnn Sligert
Patty Bowman	Joan Marshall

Sheila White	Debra Queen
Melissa Bassett	Nan Shoffner
Ronald Scott	Margaret Cantrell
Kimberly Gentry	Karen Clark
Belinda Suanders	Edith Mosley
Jane Meredith	Helen Rundle
Rebecca Hook	Sherry Dougherty
Rosann Spain	

During the second year of the project, Troy Hayden, Athletic Director and Supervisor of Physical Education at Tennessee School for the Deaf, was extremely supportive in facilitating our efforts. His teachers that worked with our rhythmicity groups, David Porter and Jeannie Faire, were most helpful. The cooperation of Sharon Brown and Richard Hancock, who worked with the control groups, is also appreciated. Don Thompson, Head, Child Study Center, provided information on hearing and speech scores, as well as general encouragement. Lastly, to the 68 children at Tennessee School for the Deaf, who worked with us and who made herculean efforts to follow our cues to move to the beat of a drummer whom they often did not hear, we extend our deepest appreciation.

PROJECT PERSONNEL

Project Director/Principal Investigator:
Wendell Liemohn, Ph.D.

Research Assistant:
Timothy Winter, Ph.D. (Year ONE)

Graduate Research Assistants:
Robing Bright and Cindy Robertson (Year ONE), Mark Battle, Harry Hitchock and Susan Shepherd (Year TWO)

Hourly Graduate Assistants:
Beth Webb, Carolyn Kaler and Carol Tate (Year ONE) and Susan Freeman and Earl Schliesman (ES was a contribution of the Division of Physical Education) (Year TWO)

Secretary: Angie Holtclaw

Project Advisory Board

External Consultants:

Charles Golden, Ph.D., Professor of Medical Psychology, Nebraska Psychiatric, Institute, University of Nebraska Medical Center

Edward Gotts, Ph.D., Director, Division of Childhood and Parenting, Appalachia Educational Laboratory, (presently Chief Psychologist, Huntington State Hospital, Huntington, WV)

Pat Brown, System-Wide Consultant in Music, Knox County Schools, Knoxville, TN

David Huntsinger, Consultant, Elementary Physical Education, Knoxville City Schools

Roberta Werner, Ed.D., Director of Special Education, Knoxville City Schools

Z. H. Brody, Director, Daniel Arthur Rehabilitation

Center, Oak Ridge, TN
Richard Yoakley, Ed.D., Director of Pupil Personnel, Knox County Schools
Troy Hayden, Supervisor of Physical Education, Tennessee School for the Deaf
Jeannie Faire, Physical Education Teacher, Tennessee school for the Deaf

Internal Consultants:

Carl Asp, Ph.D., Professor, Department of Audiology and Speech Pathology
Charles Faires, Ph.D., Associate Professor, Department of Curriculum and Instruction
Charles Hargis, Ph.D., Professor, Department of Special Education and Rehabilitation (specialization: deaf education)
Marvalene Moore, Ph.D., Associate Professor, Department of Art and Music Education
Skyler Huck, Ph.D., Professor, Department of Educational and Counseling Psychology (specialization: statistics)
Leslee Rook, Verbotonal Speech Clinician, Department of Audiology and Speech Pathology
Jean Schindler, Professor, Department of Special Education and Rehabilitation
Craig Wrisberg, Ph.D. Professor, Division of Physical Education (specialization: motor learning)

INTRODUCTION

Movement is often associated with rhythm; this is exemplified in such common acts as walking, talking, and chewing. Rhythm is basic to life but yet its genesis may precede birth. Condon and Sander (1974) noted rhythmical factors that affect the developing fetus; perhaps of more significance they noted that an infant's motor development is entrained and synchronized with adult speech. Guberina and Asp (1981), Wohl (1970), Anastasiow (1979) and Salminen (1978) cite the importance of rhythmic motor activities on a child's speech/language development. Researchers such as Tingley and Allen (1975) even suggest the belief that a "common clock" may exist for all motor timing and control. Smoll and Schutz (1978) are of the opinion that an individual might have his/her own preferred rhythm. Perhaps this thought is similar to what prompted Thoreau to write "If man does not keep pace with his companions, perhaps it is because he hears a different drummer."

Seeing children move to the beat of a different drummer initially prompted study of this issue by the principal investigator. This effort led to the development of four tapping tests designed to measure the rhythmicity of motor action. These tests require the subject to tap his/her hand in concert with the beat of a metronome (set at a cadence of 60 or 120 beats per minute) with or without a concurrent visual stimulus (the pendulum). In one investigation by the principal investigator in which factors of motor ability were analyzed in children with learning problems, rhythm was found to be a significant contributor to a subject's movement proficiency on both rhythmic, gross and fine motor items (1974). These findings suggest that a variety of tasks have either a rhythmic component or share some other commonality.

Perhaps the most exhaustive studies of rhythm were conducted by C.E. and R.H. Seashore. Although most of their research was related to studying musical talent and none of it was done with special-education populations, their findings support the relationship between rhythmic ability and other entities which are deficient in special education children. In the Seashore motor rhythm tests, subjects were instructed to tap a telegraph key in time with whatever rhythm pattern was presented. Seashore cited basic rhythm, kinesthetic memory (i.e., ability to apprehend, retain, and repeat a motor set), and general muscular coordination to be the most important factors.

Damarin and Catell (1968) found rhythmical ability to have the highest loading in a factor that they labeled "perceptual speed." In their rhythmic test, subjects clapped their hands in time with a metronome for 15 seconds and then tried to clap at the same tempo 20 seconds after the metronome was stopped.

Whitener James (1973) found "rhythmic coordination" to be a common factor for 3-4 year old and for 5-6 year old children. For the 3-4 year old children rhythmic coordination was identified as the third factor and bouncing a ball with (a) the preferred hand and (b)

two hands were the items in this factor. For the 5-6 year old children rhythmic coordination was identified as the first factor and "jumping the rope," in addition to the two aforementioned ball-bouncing tasks, were the items in the factor.

A number of other investigators have advocated the importance of rhythm in perceptual development and/or motor development. Dunsing and Kephart (1965) proposed that (1) acquisition of rhythm is a critical learning problem involving time perception, and (2) rhythmic ability develops during the learning of locomotor activities. Kallan (1970) contends that rhythm is important in perceptual organization and that in exceptional children the internal timing mechanism may often be amiss. Kravitz and Boehm (1971) noted that a low Apgar score delayed the onset of rhythmic signs and postulated that delayed rhythmic habit patterns may be of value in diagnosing developmental retardation. Nagaski and Narabayshi (1978) discovered a "hastening phenomenon" or accelerated tapping rate in individuals with Parkinson's disease. The aforementioned reports all seem to support the notion that children with rhythmic problems are more prevalent in exceptional populations.

The Russian neuro-psychologist Luria (1973) has examined the role of rhythm as it relates to motor ability in adult battle trauma victims. Luria demonstrated that lesions to the pre-motor cortex result in motor difficulties including the inability to (1) sequence geometric progressions in drawing, and (2) replicate rhythmic taps. Luria's drawing tasks included (1) simple geometric figure replication and (2) a vertical-horizontal-diagonal line continuum replication. In Luria's rhythmic task the patient is asked to tap two loud beats followed by three weak beats. Luria refers to problems that patients experience with these tasks as "efferent apraxias." Related research by the principal investigator relative to sequential fine and gross motor activities having a rhythmic basis, infers that some of the symptoms manifested in the rhythmic performance of exceptional children are comparable with those described by Luria in individuals sustaining premotor cortex injury.

More recent research by the principal investigator further supports the contention that rhythmic ability is important to motor development. In one of these investigations (1978) stepwise regression was used to determine which perceptual factors were best predictors of perfromance on gross and fine motor ability tests. The subjects were 144 mildly retarded, learning disabled, and/or perceptually handicapped children. The perceptual tests (independent variables) were (1) three of the principal investigator's rhythmic tapping test (i.e., tapping in concert with a metronome under the following conditions: visual-auditory stimulus slow (VA60), auditory stimulus slow (A60) and auditory stimulus fast (A120), (2) Imitation of Postures, Crossing the Midline, Bilateral Motor Coordination (Southern California Perceptual Motor Tests), and (3) Body Perception (Cratty, 1974). Age, sex and IQ were included with the independent variables to ascertain their role in performance. The motor tests (dependent variables) were: (1) Bender Visual Motor Gestalt Test, (2) Developmental Test of Visual Motor Integration, (3) Hopping (Purdue Perceptual-Motor Survey), (4) Ball Catching (Lincoln Oseretsky), (5)

Locomotor Agility (Cratty) and (6) Standing Broad Jump.

The best perceptual predictors of performance were the (1) VA60 rhythm test and (2) Crossing-the-Midline test. That the VA60 rhythmic test correlated weakly with age and with IQ suggests that it has an entity which is not contaminated to a great extent by these two variables which tend to have a profound impact on performance outcomes for handicapped children. The difficulties in performance of somewhat comparable rhythmic and drawing tasks by these children and Luria's subjects (e.g., the inability to sequence and perform movement smoothly), support the tenability of similar bases for the rhythmic dysfunction.

The purpose of the second study (1978) in this area was twofold, namely (1) to examine the relationship between rhythmic ability (as measured by the principal investigator's VA60 and A60 rhythmic tests) and tests purporting to assess neurologic function and (2) to make inferentail comparisons with research findings reported by the Russian neuropsychologist Luria. The subjects were essentially the same as those described previously. The tests purporting to evaluate neurlogic function were: (1) Bender Visual Motor Gestalt, (2) Beads in Box (McCarron Assessment of Neuromuscular Development--MAND), (3) Finger Tapping (MAND), (4) Heel and Toe Walk (MAND), (5) Imitation of Postures (SCPMT) and (6) CRossing the Midline (SCPMT).

The contention that rhythm is basic to the execution of many motor tasks was again supported. The fact that (1) there were significant correlations between the rhythmic test scores and all but one of the tests purporting to assess neurologic function and (2) many of these coefficients increased with the partialing out of age further supports the belief that arrhythmicity may be related to neurlogic dysfunction.

Stepwise regression was used to determine the role that rhythm played in select psychomotor skills in a previously cited investigation (1978). Although at the time the statistical choice appeared appropriate, its inherent drawbacks (in this case Beta weights were effected because of multi-collinearity) in reality could mask rhythm's contributions to the tasks. To rectify this extant situation another investigation (1982) was undertaken in which the original and subsequently collected rhythmic data (total N=175) were first factor analyzed; the ensuring rhythmic factor coefficient was then used in the regression analysis with age as a marker variable. The resulting rhythmic structure coefficient was a better predictor of performance than was age on 9 of the 11 psychomotor dependent variable (i.e., Bender Gestalt, Developmental Test of Visual Motor Integration, Hopping and 6 subt-tests of Cratty's Locomotor Agility Test. The rhythmic structure coefficient on average accounted for 26 percent of the <u>total</u> variance; moreover it accounted for 35 percent of the total variance for the subject population's performance on the Bender Gestalt test. These findings emphasize the integral role the rhythmicity plays in the development of psychomotor skills in special populations.

The test series was next administered to 143 children who were in

regular education placements. The percentage passing each test for the special education placement population (N=153, Mean Age=9.4 years, standard deviation=25.4) versus the regular education placement population (grades 1-4, approximately 36 children for each grade) was (1) VA60, 33.8% vs. 78.9-97.6%; (2) A60, 32.1% vs. 73.7-92.7%; and (3) 44.1% vs. 76.3-95.1%. As might be expected the first graders did not perform as well as the second to fourth graders; however, moreso than maturity a possible reason for this finding might be that a greater percentage of these children were yet to be identified for a special education placement. The latter contention was supported by the fact that little variance in performance was seen among the children in grades 2-4. However, the major point is that arrhythmicity is much more prevalent in children in special education placments than it is in children in regular education placements.

A multisensory rhythmic remediation program appears most plausible when one examines the research of Luria and that of the principal investigator. Although the types of tasks used by both researchers varied, the symptoms manifested (i.e., the inability to sequence and perform tasks smoothly) were seen by both. Luria (1963) is of the opinion that lesions to the premotor cortex preclude the smooth performance of skilled movements and hence each link of the movement fails to connect smoothly with the succeeding one (i.e., in Luria's words a "kinetic melody" is missing). Luria believes that by utlizing auxiliary stimuli (e.g., auditory mnemonics, pictures/signs representing rhythm, and overt counting), compensation can take place as these external aids take root and promote the development of internal rhythm mechanisms. Luria's remediation program is only supported by case studies, but does provide a basic idea for a multisensory rhythmic training. This idea is also supported by the work of others.

Wight (1937) noted that "rhythmization" improved in "crippled" children who participated in an 18 session rhythmic training program. Ross et al. (1973) found that 14 EMR children (ages 87-118 months, IQ's 57-79) improved significantly after participating in a 4-week rhythm training program containing items such as marching, clapping and "jumping on beat." Larson (1978), in a pilot study with 5 experimental subjects, found that learning disabled children subjected to a "Motorvator" training program of 5 weeks improved significantly on their post-training scores on the Purdue Perceptual Motor Survey.

Mulhern et al. (1974) found that rhythmic pulsations facilitated the duplication of acoustic signals in both retarded and nonretarded children. Furthermore, their investigation showed that rhythmic organization improved performance of retarded children. Rossignol and Jones (1976) examined techniques of facilitation and habituation of the H-reflex (i.e., using neuronal pathways of the startle response). They concluded that rhythmic auditory stimulation (as presented in some music) could be used purposefully in audiospinal facilitation (i.e., promote the synchronization of stereotyped motor response).

Giacobbe (1972) believes that rhythm in music can aid neurologic integration in "brain-damaged" children. He also postulates that rhythmic training can facilitate organizational and sequential

abilities important to development. McKinlay (1978) suggests the inclusion of "music and rhythm training" in remedial reportoires for clumsy children. Cratty (1974) state that different types of rhythmic activites may improve performance in perceptual-motor skills. Arnheim et al. (1977) believe that synchrony and rhythm "are essential in the development of a broad base of activites that enable the learner to adapt efficiently to his environment." In a chapter entitled "Cultural and Primate Bases of Education," the anthropologist Hall, suggests the plausibility of dyslexia being cured by having one perform rhythmic movements of the body.

Although many have hypothesized that rhythmicity and/or rhythmic training is/are important in the development of a child, there are limited substantive data which support these contentions. The hypothesis that rhythmic training can be a factor in improving rhythmic skill is tenable, and on the basis of the information available warrants investigation. Although this research would not purport to answer every question relative to the benefits of rhythmic training for the special child who is arrhythmic, it would be a major step in delineating the efficacy of rhythmic training for improving motor skill in exceptional children. It could furthermore lay the groundwork for future research which could examine the role of rhythmicity and rhythmic training as they relate to language and/or other factors of development.

The purpose of this investigation was to determine the efficacy of a multisensory-rhythmic training program in improving rhythmic skill (as measured by the tests which require the child to tap his/her hands in concert with a simple even rhythm) in children who were labeled as being (a) educable mentally retarded or learning disabled (Year ONE) and hearing impaired (Year TWO).

AN INTERDISCIPLINARY APPROACH TO TRAINING THE ARRHYTHMIC CHILD--PROJECT REPORT ABSTRACT YEAR TWO*

Wendell Liemohn, University of Tennessee--Knoxville

An inherent rhythmicity and/or its development may be basic to many cognitive and sensory-motor skills; however, with the exception of (a) a few case studies reported by the Soviet neuropsychologist Luria and (b) limited research in speech therapy, there have been no systematic attempts to teach rhythmicity to the arrhythmic. By the very nature of their handicap the hearing impaired, who typically have a concomitant deficit in temporal awareness, present a unique study population in which to examine the effects of rhythmicity training. The purpose of this investigation was to determine if rhythmicity test performance of the hearing impaired could be improved by their participation in a rhythmicity-training program consisting of 14 30-minute lessons over a 5-week period. The subjects were 43 children enrolled in the 5th and 6th grades at Tennessee School for the Deaf. Rhythmicity performance was defined as the subject's ability to alternately tap two microswitches with a computer generated rhythmic signal presented at 750 msec. intervals either (a) visually by a flashing light or (b) tactually by a vibrotactile unit. The visual stimulus was a 2-cm. square flashing light 56 cm. in front of the subject; the vibrotactile stimulus was a Suvag VIBAR strapped just above the subject's right lateral malleolus. Stimuli modalities were presented in counter-balanced order; subjects had three trials for each modality. In the initial testing one half of the children in each class received the visual and the other half received the tactual test first; no ordering effect was noted. Matched pairs were then assigned to either the (a) experimental program or (b) control program. Due to software problems with the test equipment, data analysis was based on a post-test conducted 11 weeks subsequent to the conclusion of the training programs. In the post-test each trial included a 6-tap warmup; each child was then tested on his/her ability to tap in concert (with) and subsequent to (without) stimulus presentation. With and without scores were computed for each modality; each was based on the mean of 8 interval scores for the three trials.

Lack of homogeneity of variances between the treatment and control groups precluded a comparison of means as originally planned. Therefore, a non-parametric technique (SAS's PROC RANK program) was first run; this was followed by a two-factor analysis of variance with "groups" as the between factor and "mode" as the within factor. The differences between the treatment and control groups were found to be significant and in favor of the treatment group ($\underline{P}$'s = .05 and .10 for the "with" and "without" stimuli condition, respectively). The combined treatment and control groups performed better in response to the vibrotactitle stimulus than than they did in response to the light stimulus ($\underline{P}$'s = .01 and .10, respectively). This research supports the efficacy of (a) rhythmicity training as used in this investigation and (b) the vibrotactile modality of stimulus presentation for the hearing impaired.

*This was the second year of a Field Initiated Research project funded by the Office of Special Education and Rehabilitative Services, Department of Education (Project No. G008300016).

METHODS AND PROCEDURES--Year ONE

Because the Advisory Board meeting conducted on August 22, 1983, impacted on several of the objectives, a brief overview of this meeting will be presented first. All four of the external consultants and five of the six internal consultants identified on the original grant application attended this meeting (the two out-of-state external consultants also met with the PI on August 21st). The external consultants in attendance were: (a) Dr. Golden, medical psychologist, University of Nebraska College of Medicine; (b) Dr. Gotts, developmental psychologist, Appalachia Educational Laboratories; (c) Ms. Brown, music supervior, Knox County Schools; and (d) Mr. Huntsinger, elementary physical education supervisor, Knoxville City Schools. The internal consultants in attendance were: (a) Dr. Moore, music educator; (b) Dr. Huck, statistician; (c) Dr. Asp, speech scientist; (d) Dr. Schindler, special educator; and (e) Ms. Rook, speech clinician. Also in attendance as a new consultant was Dr. Faires, a curriculum specialist. Dr. Wrisberg, a colleague of the PI whose expertise is in motor learning, could not attend but consulted with the PI during the summer months. Representatives from each of the three public school systems that would be involved in the project were also invited; however, only one system was represented because of inservice-training commitments. (Subsequently each met with the PI.)

The Head of the Biology Repair shop, and his software programmer, also were in attendance; they had just completed the debugging of the auditory facet of the test protocol that morning. They (a) demonstrated the auditory rhythmic test and the equipment operation and (b) described the visual protocols that the equipment would permit. The Advisory Board approved the auditory rhythmic test protocol and endorsed the plan for the development of the visual rhythmic test.

Dr. Carl Asp (speech and hearing scientist) encouraged the incorporation of a tactual rhythmic signal of the type that he used in his research, as an additional stimulus modality. His idea was endorsed by Dr. Charles Golden (medical psychologist, and a recognized authority on Luria), and then by the Advisory Board as a whole; however, subsequent equipment design delays precluded its implementation in Year ONE of the project.

The Advisory Board reviewed the process being followed in the development of the training curricula. Examples and format for the activity plans were also discussed, as were procedures to be followed in the grouping of subjects in the training and control groups. For logistic reasons, a minimum training/control group size of 5 and a maximum of 9 in any school was thought to be appropriate; if any school were to have 10 or more children who did not meet the criterion for rhythmicity, that school would have 2 or more training/control groups. Each member of the Advisory Board also responded to a written questionnaire which they received one week after the meeting; the questionnaire was designed to get further reaction to the project plan as well as to the Advisory Board Meeting. (This information was shared with representatives of the two school systems who were not

able to attend the meeting.)

Project Objectives Year ONE:

(1) To develop, assemble and field test the rhythmic testing equipment.

The testing equipment was based on (a) the principal investigator's original metronome test developed in 1972 (and subsequently used in research with exceptional children, and (b) a modification of the prototype rhythmic testing equipment developed and field tested with non-handicapped grade school children in 1979 (i.e., a pen-ink recorder, an electronic timer and a pair of telegraph keys). The head of the Biology Service Facility at the University of Tennessee (the shop best equiped to design the equipment) encouraged the PI to use a microcomputer as the basis of the test equipment.

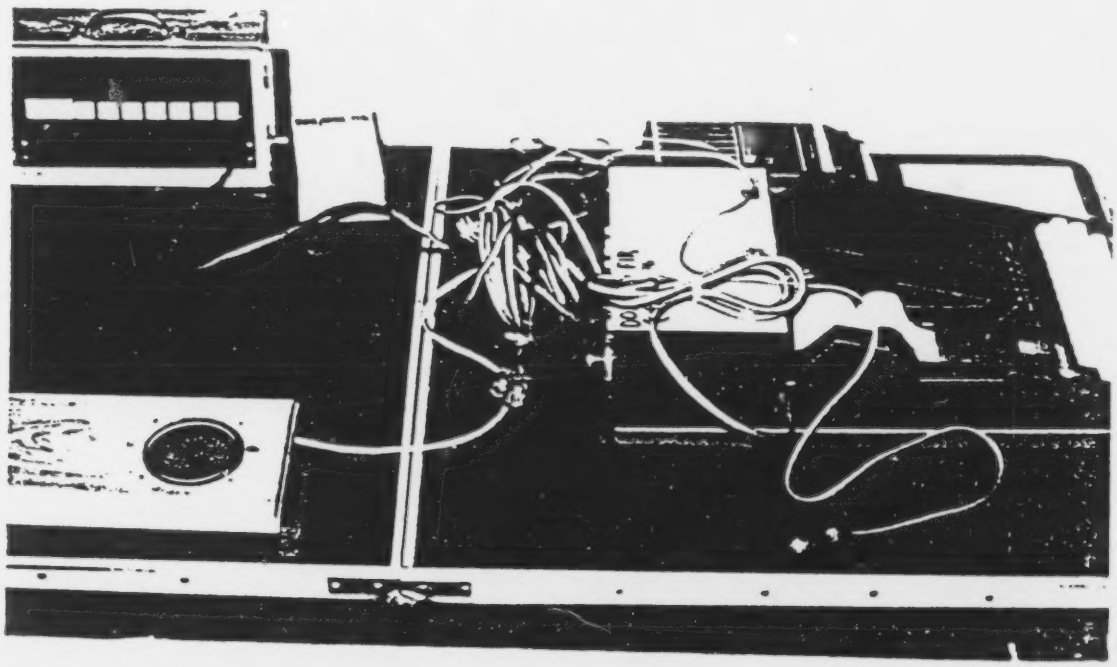
The testing equipment (i.e., microcomputer and its hardware) is depicted on the following page. It includes an AIM 65 microcomputer (North American Rockwell) that is driven by a tape player. The latter can be programmed to generate a rhythmic signal at innumerable Hz levels (i.e., 1 Hz = one signal per second, 1.5 Hz = one and one half signals per second, 2 Hz = two signals per second); during the first year of the project the computer was interfaced with either a visual or an auditory stimulus presenter; the latter were (a) a light array and (b) a speaker.

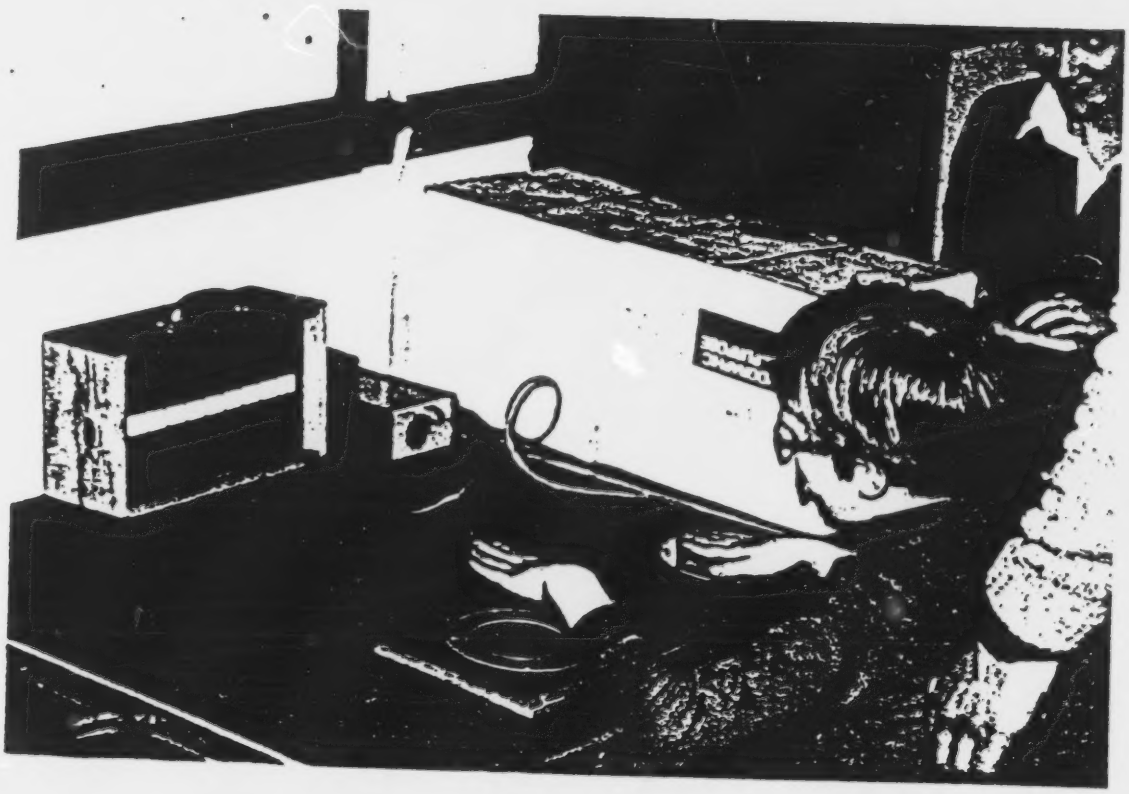
The light array was designed to simulate the swinging pendulum effect of the original metronome testing equipment. The visual stimulus evolved from a series of 7 lights shielded by a green screen. The lights would sequentially illuminate as the electrical impulse traveled initially from the left to the right and when the last light on the right was lit all would disappear. A new trial would then begin from the right side and the same sequence of illumination would occur again until the last light on the left was lit, after which all would distinguish. This pattern continued until 15 total passes or trials were presented.

The auditory stimulus involved a simple beep emulator which would elicit 15 beeps at whatever rate the testers selected. In testing, the subjects would tap their hands in concert with the rhythmic stimulus presented on two disks covering two pressure sensitive microswithces.

(2) To develop curricula that will delineate 10-week programs (i.e., 20-30 minute periods) involving:
(a) multisensory rhythmic training activities,
(b) psychomotor (perceptual-motor) training activities devoid of rhythm,
(c) non-motor activities (control group).

The two music educators, a speech clinician (who has extensive experience in using gross motor activities in the verbal-tonal method of speech therapy) and the elementary physical education education consultants worked closely with the project staff; the latter included: (a) Tim Winter, a Ph.D. candidate specializing in motor





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learning as well as in adapted physical education, (b) Cindy Robertson, an undergraduate specialization in dance and an M.S. student in adapted physical education, and (c) Robin Bright, an M.S. student in adapted physical education. The latter three also worked on the development of the perceptual-motor training curriculum.

The original research design proposed a rhythmic training group, a perceptual-motor training group, and a Hawthorne (non-motor) control group; the latter group was to be read stories and be shown educational films. The expected benefits of this control program was of concern to the PI; to rectify this problem the special education consultant for Year ONE of the project (Jean Schindler, Ph.D.) was asked to develop experiences for this group that could be beneficial. She developed a language-orientated curriculum which included (a) the reading of a short story (written by J. Schindler and one of her graduate students) to the children who were subjects in this group and (b) a guided discussion. Two M.S. students in Special Education (Carolyn Kaler and Carol Tate) taught these lessons to the Hawthorne control subjects.

All training/control groups were taught in their respective schools during regular school hours; each group received 20 thirty-minute periods of instruction with the Project Staff. The curriculum for the experimental group is delineated in the manual developed in the Project; it is titled RIGORS AND RHYTHMS.

(3) To test area educable mentally retarded and learning disabled children during October and November, 1983, on the rhythmic test series; on the basis of the criterion score selected, assign children randomly to the training and control groups.

Subjects for the first year of the project (i.e., 1983-84) were limited to children who had been diagnosed as being educable mentally retarded or learning disabled. All subjects were between the ages of 7-10 years (i.e., 10 years of age as of October 1, 1983). Age 7 was chosen instead of the original 6 year figure because younger children might not be representative of the learning disabled/educable mentally retarded population. Age 10 was chosen because perceptual skills often reach their asymptote by this age (Birch & Belmont, 1965).

After the test was piloted, the original plan was to begin the testing in the Knoxville City Schools. (The Knox County School system had requested that a neurologist insure them that the light stimulus would not be apt to cause seizures. The test equipment and protocol were demonstrated to a neurologist; he endorsed it but there was a delay in receiving his letter of endorsement.) The special education director of the Knoxville City Schools wished to contact the schools and to distribute the PI's introductory letter to parents rather than have the PI do this. There was some delay in this process; however, the director of special education in Anderson County made arrangements to test in the Daniel Arthur Center (a school for the handicapped). After testing was completed there it was then begun in six Knoxville schools; including the Knoxville Adaptive Education Center, a school for the handicapped. During the interim the PI met individually with

the eight county principals of target schools to explain the research design; the principal's special education teachers usually were in attendance. All of these principals were most cooperative and endorsed the project; testing was begun in these schools in December after (a) the neurologist had endorsed the test protocol in writing and (b) parent permission letters had been returned.

The original testing was conducted only in those schools which had a minimum of one self-contained EMR and/or LD classroom (these schools also had at least one additional resource room teacher). Since a desired number had not yet been tested in the city schools, the PI was permitted to contact an additional five principals of schools with just resource room teachers (i.e., no self-contained special education classrooms). Testing was completed in these schools after the Christmas break.

All tests were administered by Project Staff. At the initial session each child received an explanation of the procedure, a practice or warm-up trial (15 stimuli presentations) first for the visual modality at rate of 1 Hz and then an auditory trial at the same Hz. The testing was then begun and each subject received three trials at each Hz/modality combination; each trial was to include 10 possible scored hits preceeded by 5 warm-ups. The following tests were then presented in a counter balanced order:

(1) Visual signal at 1 Hz (i.e., 1 stimulus per second)
(2) Visual signal at 2 Hz (i.e., 2 stimuli per second)
(3) Auditory signal at 1 Hz,
(4) Auditory signal at 2 Hz.

Data from the testing of 268 children were entered on computer cards; the data were: (a) absolute error (AE) scores for the 2 one-Hz tests and (b) hit scores for both the one and the two Hz tests. The inter-tap interval was too small on the 2 Hz tests to ascertain AE scores. The following were selected as indices of arrhythmicity:

(1) AE scores equal to greater than 250 milliseconds (ms.) on 2 of 3 trials for each of the 1 Hz tests.
(2) Hit scores equal to or less than 8 or equal to or more than 12 on any 2 of 3 trials of any of the 4 Hz/modality tests.
(3) The subjective judgement of the research assistant in charge of the testing.

Therefore an individual could be judged as being arrhythmic on the basis of his/her AE scores (2 chances), Hit scores (4 chances) or subjective judgement (1 chance). Anyone meeting 3 or more of these seven criteria was labeled as being arrhythmic for purposes of this investigation. By using this process 134 children were classified as being arrhythmic.

Eighteen "subject groupings" were identified from 16 different schools. (In three of the schools in which testing was done, fewer than 5 arrhythmic children were identified.) The principals (and/or their special education teachers) indicated the times that their children could be involved in the project (i.e., 2 30-min. periods each week). Since it was not possible to randomly assign each child to the treatment or control conditions, each of the 18 groupings was

randomly assigned. This was done by arranging the groups by size; this resulted in 6 groups each in the small (5-6), medium (6-8) or large (8-9) category. Each of the 18 groups was then identified on small slips of paper; the groups identified on the first 2 slips drawn were placed in the Hawthorne control group, the next 2 were placed in the perceptual-motor group and the last 2 were placed in the rhythmicity group. The same procedure was followed for the medium and large groupings. With project staff it was possible to cover all available times for the rhythmicity and the perceptual-motor training; however, the class schedules of the two special education M.S. students who were to work with the Hawthorne control group necessitated additional redrawing to facilitate their scheduling. This additional redrawing resulted in smaller-sized Hawthorne-control groups; however, randomness was still achieved. (The two groupings from the two special schools in the project, i.e., lower functioning children, both were selected to receive rhythmicity training by this process. The PI would have obviously not chosen them for this group.)

Schedules were then negotiated with each principal; it was possible to schedule all but 3 of the identified children. (The principals and special education teachers in these 16 schools were exceptionally cooperative.) The make-up of the respective groups by size was: (a) rhythmicity--42 (9, 8, 7, 7, 6 & 5); (b) perceptual motor--43 (9, 9, 8, 6, 6, & 5); (c) Hawthorne/language--37 (9, 6, 6, 6, 5, & 5). (Subsequent to the pre-testing and prior to the completion of the training/control programs, two children transferred from the Hawthorne/language groups to different schools; therefore only 35 children completed this program.)

The 6 rhythmicity and 6 perceptual-motor training groups were taught by project research and graduate assistants. The 6 Hawthorne/language groups were taught by two graduate students in special education. All training was totally conducted by project personnel; public school teachers/personnel may have observed at times, but they did not directly assist. (They were most helpful, however, in implementing/conducting all facets of the project.)

(4) To post-test, following training and test again for retention after an 8 week interval, all children completing the training and control programs, in order to determine the efficacy of the multisensory rhythmic training program in improving and sustaining rhythmic skill.

One hundred twenty children completed the training/control programs, and were post-tested, as well as being retested for retention after a 6-week interval.

The first objective for the Year TWO of the project is more appropriately covered here; it was:

(1) To analyze the data to determine the efficacy of the multisensory rhythmic training curriculum.

RESULTS--YEAR ONE

Chronbach's alfa reliabililty coefficients for the modality/Hz combinations were: (a) Visual 1 Hz, $\underline{r}$ = .83 for Hits and .77 for Absolute Error (AE); (b) Auditory 1 Hz, $\underline{r}$ = .71 for Hits and .79 for AE; (c) Visual 2 Hz, $\underline{r}$ = .77 for Hits; and (d) Auditory 2 Hz, $\underline{r}$ = .56. The $\underline{r}$ for the Auditory 2 Hz test was not acceptable; therefore this test was dropped in all other data analyses.

Analysis of covariance was used to determine if improvement resulted from any of the three treatments with respect to the (a) modalities (visual or auditory) and (b) Hz (1 or 2) of stimulus presentation. In essence this is a 3 X 2 X 2 X 2 design with the pre-test scores as the covariate for the post-test and retention-test. The results of these analyses are presented in a summary table on the following page.

The summary table indicates that the rhythmicity training program did not significantly affect the participant's post-test rhythmicity scores. The only significant finding was that the post-test scores were related to the pre-test scores (i.e., the covariate). (Although not depicted in the summary table, the retention rhythmicity scores were not influenced by the training either.)

DISCUSSION OF RESULTS--YEAR ONE

These findings are in contrast to the subjective observations of the teachers of the rhythmicity skill classes; they were of the opinion that the rhythmic skills of their children improved. There could, however, be several reasons for this disparity. These reasons could be related to (a) the process of subject selection, (b) the lack of intensity and/or specificity in the training and/or (c) hardware and software equipment problems. (The experiences gained in Year TWO of the project enable interpretations that might otherwise not have been realized relative to the fallibility of the test equipment.)

The procedure followed for subject selection was described earlier; on the basis of the information known at the time, it appeared to be very objective. As was indicated previously, the only two special-school subject groupings of the 18 were both assigned to rhythmicity training by the "draw" procedure that was followed. Because of their lower functioning levels and more severe behavior problems, hindsight suggests that they should not have taken part in the research. At the research's inception, however, the subject pool that had been anticipated to be available in the "regular" Knoxville City Schools was not realized. Because of the research design, the PI believed that quantity of subjects was a most important factor. Theoretically, the lower functioning level of the children in the special schools could suggest a potential for more improvement.

During the training/control periods the PI made a process evaluation of the training taking place in all groups. Although the emphasis was placed on observing the rhythmicity training (28 of these sessions were observed), the PI also made it a point to observe as

SUMMARY TABLE--YEAR ONE

Analysis of Covariance

Source	df	SS	MS	F	PR>F
Visual 1 Hz--Hits					
Within	14	195.89	13.99		
Between					
Covariate	1	90.60	90.60	6.47	.023
Group	2	.74	.37	.03	.974
Visual 1 Hz--AE*					
Within	14	68,846.82	4,917.63		
Between					
Covariate	1	36,078.12	36,078.12	7.34	.017
Group	2	8,049.47	4,025.74	.82	.461
Auditory 1 Hz--Hits					
Within	14	49.95	3.57		
Between					
Covariate	1	14.05	14.05	3.94	.067
Group	2	4.51	2.26	.63	.546
Auditory 1 Hz--AE*					
Within	14	97,652.53	6,975.18		
Between					
Covariate	1	35,496.88	35,496.88	5.09	.041
Group	2	215.78	107.89	.02	.985
Visual 2 Hz--Hits					
Within	14	92.09	6.58		
Between					
Covariate	1	24.50	24.50	3.72	.074
Group	2	.59	.29	.05	.956

*AE SS and MS in thousands

many of the two control groups' training as possible (37 of these sessions were observed). Through these observations it was noted that, although the behavior problems seen in the special schools may have been more severe, behavior problems were not limited to the two special schools. However, one of the additional schools in which behavior problems undoubtedly had a deleterious effect on training was also assigned to rhythmicity training; the problems encountered here may have been exacerbated by the facts that the (a) group size was large--9, (b) training environment was poor and (c) rhythmicity teacher had minimal experience. The other school in which behavior problems were encountered was in a perceptual-motor training group; here again the group size was large--9. The fact that few behavior problems were encountered in the language control group may be explained by the fact that (a) group sizes were generally smaller and (b) their teachers were experienced special education teachers.

When the rhythmicity training curriculum was developed, the Advisory Board encouraged use of materials that were readily available to resource room teachers; therefore the intensity of the rhythmicity training may have been limited by the more conservative approach that was followed in its teaching. It is also possible that the types of skills practiced in the rhythmicity training lessons were not specific enough to the rhythmicity testing; in other words the rhythmicity skill that might have been acquired was not generalizable to the testing environment. This possibility might have been teased out if a simpler subjective rating scales had been used to compliment the computer-based rhythmicity tests.

It is also possible that hardware and software problems in the rhythmicity testing equipment may have precluded the (a) finding of significant results and/or (b) seeing more definable patterns of scores. At times the keys that the child tapped would stick; it is possible that this occurred more often than was realized by the testers. After the Year ONE data was analyzed, the testing equipment and protocol were studied extensively. During this process it was recommended that "windows" be established to determine correct rhythmic responses in contrast to the absolute error scores used in Year ONE.

METHODS AND PROCEDURES--YEAR TWO

The first objective for the second year of the project concerned data analysis for Year ONE; it was covered in the preceeding section. The remaining objectives for the second year of the project were:

(2) To develop the necessary hardware and software so that tactual stimuli can be added to the existing auditory and visual rhythmic stimuli in the existing test protocol.

A SUVAG Vibar, of the type used in speech therapy, was purchased to transmit the vibro-tactual stimuli; an amplifier was also purchased since the existing hardware could not drive the the Vibar. Pictures of this equipment appear on the following page. Because of difficulty in interpreting the raw data from Year ONE, windows for correct hits (rather than AE scores) were programmed into the computer used in the testing. At the time it was assumed that this would facilitate scoring.

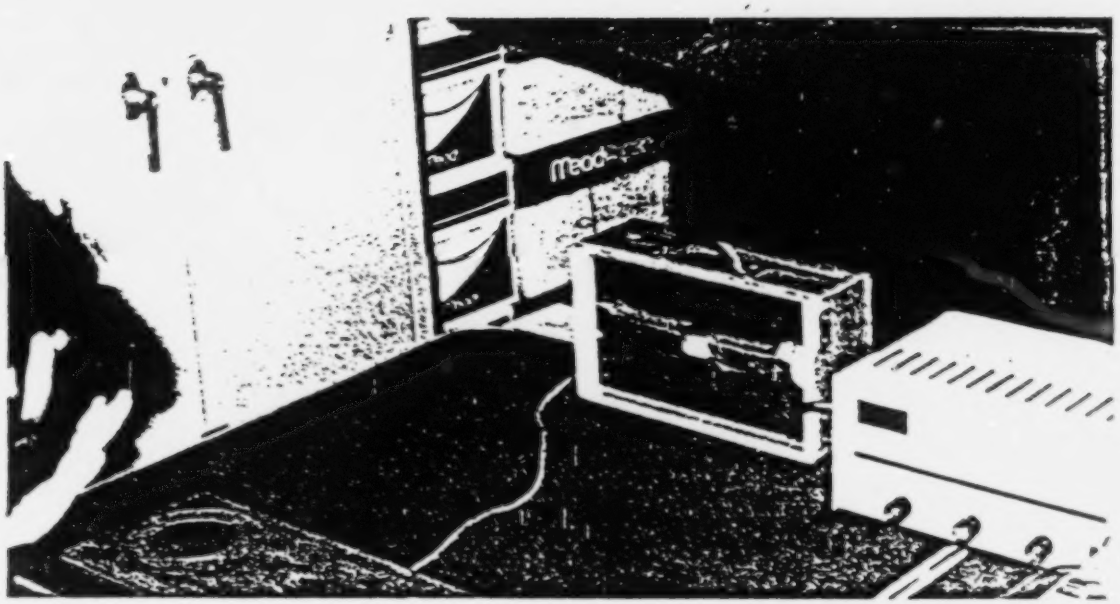
A meeting of the Advisory Board was held in August, 1984. At this meeting it was decided to reduce the light stimulus to a single light rather than the light array used in Year ONE. This change was recommended by one of the outside consultants, Dr. Gotts, for the following reasons: (a) the stimulus would then carry no forewarning as was the case for the new Vibar stimulus as well as Year ONE's auditory stimulus and (b) the realization that this change could obviate a potential scoring problem that had just been uncovered. (This change merely necessitated placing a screen over the "light box" so only the middle light was visible; no software programming changes were necessary.)

(3) To modify the existing multisensory rhythmic training and perceptual-motor training curricula, as needed, for use with the hearing impaired.

One of the new project research assistants (Mark Battle), who had a degree in Deaf Education and 8 years of teaching experience at the Florida School for the Deaf, one of the outside consultants from Tennessee School for the Deaf (Jeannie Faire), a second new project research assistant (Susan Shepherd), who had a degree in Special Education and 8 years of teaching experience, and the PI modified the curriculum used in Year ONE. The additional types of equipment utilized included:

(a) strobe light (its reostat switch permitted changing the tempo of the rhythm).
(b) bass drum (and high decibel music with a strong bass)
(c) rebounders (a mini trampoline was used by each child in the last few minutes of each training session)
(d) balloons (the latter picked up strong bass sounds and provided an excellent rhythmic tactual stimulus)

During Year TWO of the project a much greater emphasis was placed on the trainee's counting (verbalization) while performing the



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rhythmic activities. This technique purportedly was used by Luria (1963) to teach rhythmicity to individuals sustaining head trauma; Luria was of the opinion that this procedure facilitated the trainee internalizing the rhythm. Rhythmic counting is also very similar to the rhythmic verbalization used by verbotonal speech therapists; however, in the latter a broader spectrum of Hz ranges is used by word choice. In counting 1-8, the only low to middle Hz sounds are in the numbers ONE and TWO; therefore, this aspect of our treatment was only a quasi verbotonal treatment since the numbers 3-8 stress middle to high Hz sounds.

(4) To test the rhythmicity of approximately 150 TSD students whose prime handicap is a hearing impairment.

From a logistic perspective, we found it possible to teach only two classes in any given time period. The first group of TSD children participating in the Project were 3rd and 4th graders; they were between the ages of 9 and 12. Just prior to the implementation of the program, these two classes were merged to form one class of 21 children. This merger, because of smaller than expected classes for these grades, occurred too late to enable the scheduling of a second class.

The 3rd and 4th grade children were pretested in the last week in October. The testing procedure followed was essentially the same one used in Year ONE except that (a) the aforementioned Vibar stimulus replaced the auditory one, (b) only one light flashed in the visual test, and (c) stimuli were presented at 750 millisecond (approximately 1.3 Hz) intervals. (During Year ONE stimuli were presented at both 1 and 2 Hz (1,000 and 500 msec., respectively); however, for the hearing impaired child it was recommended, and pilot testing with another class supported this recommendation, that we reduce the length of the testing period. Tests were again administered in counter-balanced order. The 5th and 6th grade subjects were tested in the first two weeks in January.

In the pre-tests one half of the subjects in each of the (a) 3rd and 4th, (b) 5th and (c) 6thth and sixth grades received the visual modality presentation first and the tactile modality presentation second (V-T odering); the remaining subjects received the tactile presentation first and the visual second (T-V ordering). There was not an ordering effect. With the exception of the scores of the five children with verified disabilities other than hearing impairments (e.g., cerebral palsy), all pre-test scores were then ranked by total number of hits (i.e., microswitch taps during each trial) within both the V-T and the T-V ordering groups of each class. No attempt was made to look at the accuracy of the scores prior to group assignment. Within each of the modality ordering groups two sub-groups were further delineated; those with the highest scores and those with the lowest scores. Individuals within the four sub-groupings were then randomly assigned to the treatment and control groups. Ten 3rd and 4th graders were assigned to the treatment group and 10 were assigned to the control group. Twelve fifth graders and 11 sixth graders were assigned to the treatment group; identical numbers from each grade were assigned to the control group. (The five children with verified

disabilities (i.e., 4 with cerebral palsy and one with a learning disability) were not considered when the group assignments were made; however, they did participate in the training of either the treatment or control groups. Each participated in a perfunctory post-testing for purposes of their beneficence only.)

The 3rd and 4th grade subjects were trained in November and December. Two of the project staff members were the teachers for both the experimental and control groups and controlled the the content of each program; each group was assisted by a TSD physical education teacher. The 3rd and 4th graders were posttested just prior to the Christmas break. Originally all children were scheduled to receive 15 one-half hour periods of training (i.e., 3 periods per week); however, fear that some parents of children in the 3rd and 4th grade might remove a child early for the Christmas recess resulted in our reducing the number of training periods to 14.

The 5th and 6th grade classes met at different hours; however, they received the same training and it was conducted by the same personnel. Because of the maturity of the 5th and 6th graders, the rhythmicity training program was more intense and covered more material than had been presented to the 3rd and 4th graders. The post-testing was conducted after 14 periods of training. (We had originally planned to implement the program with the 1st and 2nd graders during April; however, other factors to be elucidated precluded doing this.)

A process or formative evaluation of the rhythmic training program was conducted by the PI of every lesson; 6 internal consultants also observed at least one lesson. These observations contributed to an ongoing revision of the curriculum; although the curriculum for the 3rd and 4th graders was unique to their group, the training received by the 5th and 6th graders was the same.

(5) To post-test, following training and test again for retention after an 8 week interval, all children completing the training and control programs, in order to determine the efficacy of the multisensory rhythmic training program in improving and sustaining rhythmic skill.

(6) To analyze the data to determine the efficacy of the multisensory rhythmic training program with hearing impaired.

In the process of analyzing the data, despite computer software changes initiated to obviate the equipment problems realized in Year ONE, it became evident that there were still difficulties in interpreting raw scores. These problems were elucidated by subjecting the test equipment to unique patterns of test response in a lab-type setting. After a considerable amount of study of the patterns on the computer test equipment print-outs, we were able to delineate contributing factors; it became evident that they were of such a nature that it was impossible to "match" specific responses made by a child to the stimuli which precipitated the response. An explanation

of the problems found is presented below.

A stimulus cycle was the period between one Light or (Vibar) stimulus and the next. In the design, the computer logic set/reset the interval timer at the start/stop of each stimulus cycle. A "response" was recorded each time there was detected a change in the signal being generated; this meant that either touching or releasing the response key generated a signal change. Although a part of the problem may have been mechanical, the major one was one of software design.

(1) Mechanical Problems. Soft taps might not be recorded. In some cases it is possible that the response key stuck after being activated; if it remained activated, it could have blocked out subsequent hits. (We doubt that this problem could have affected many scores; it is a problem that we found possible under "laboratory" conditions.)

(2) Software Design Problems. The software was designed to record within a stimulus cycle only the first occurrence of a response by each hand; if a second response occurred within this stimulus cycle by either hand, it was blocked out. The result was missed and extra responses with post hoc detection being impossible. It was also possible that during the "warm-up" a subject could miss one response and present a perfect pattern on computer print-out. This would result in the appearance of precise data yet all the "early" scores could actually be "late" scores and vice versa. There was not any way to detect this; therefore any analysis of anticipation or reaction was impossible even with perfect appearing response on the computer test printout. (The first of the two factors mentioned we believe was the major reason that precluded an accurate interpretation of the data.)

What in essence the above meant was that any further analysis of the pre and post-test data (as well as administering re-tests for retention), and further testing with the 1st and 2nd grade classes, would be meaningless. When these problems were realized, a meeting of the Internal Advisory Board was held in April, 1985. The only viable solution emanating from this meeting was to vidio-tape the subjects performing some activity that required a certain amount of rhythmic skill (e.g., calisthenics) and to then have raters not familiar with the project rate each child's rhythmic skill. Steps were taken to implement this suggestion and the 5th and 6th grade children participating in this study were vidio-taped in May. A 7th grade class was also vidio-taped; it provided a means of establishing inter and intra-rater reliability prior to rating the actual study groups.

The PI also met with the Head of the Biology Services Facility to see if the test equipment could be reprogrammed. After delineating the specific problems encountered, this individual (i.e., he also was the designer of the equipment) said that the following changes would rectify all extant problems:

(1) Mechanical Problem. The microswitches would be replaced.

Warning lights would be installed on a panel in front of the tester; the latter would serve to flag any "soft taps."

(2) Design Problem. The computer could be reprogrammed to record interval scores rather than attempt to record absolute error scores (as in Year ONE) or taps within the correct "window" (as in Year TWO). Although this would preclude making the determination that the response taps were in exact concurrence with the test stimuli, it would permit making an exceptionally accurate determination of the tempo that the respondent was using. These could then be compared with the response interval set (i.e., 750 msec.).

The PI was furthermore assured by the Head of the Biology Services Facility that it would be impossible to "lose scores" with the new protocol and that the software programming for this test protocol was much easier to develop than the protocols that we had previously requested. (What this in essence meant was that the test protocols used previously were in reality beyond the capabilies of our AIM 65 microcomputer.)

Because so much of the prior collected data had been rendered meaningless, the PI recommended an additional change which in essence might contribute to the research questions being addressed. Some of the rhythmic research previously done in psychological research included a period wherein subjects attempted to maintain the rhythm after the stimulus was withdrawn (Damarin and Catell, 1968). Because temporal awareness appeared to be such a problem in the hearing impaired, it appeared that this type of information could potentially be a valuable adjunct to the research literature. The PI was advised that this change could be easily be made to the test protocol.

After all the aforementioned changes were made, project staff put the test equipment to task under severe "laboratory-stress" conditions. One minor problem was uncovered; it was corrected by the Biology Service Facility. Post-testing (or in essence a test for retention of the training) was begun on May 27th; this was 11 weeks after cessation of the rhythmicity training program. This final testing was done by the PI with assistance of one project assistant and a TSD physical education teacher. Intraclass correlation coefficients were computed for each grade/modality combination for the three trials; they were .88, .83, .83 and .73).

(The 5th and 6th grade children were retested 11 weeks after their training period had concluded. The 3rd and 4th grade children were not retested because 24 weeks had elapsed since their training had concluded.)

RESULTS--YEAR TWO

The post-test means and standard deviations are presented in Figure 1. The treatment group is represented by 11 5th graders and 10 6th graders; the control group is represented by 11 5th graders and 11 6th graders.* All stimuli were presented at 750 msec. intervals; therefore the best score attainable was 750. Figure 1 shows that (a) the means for the experimental group are always larger and closer to 750 msec. than the means for the control group, (b) the means for rhythmic response to the Vibar (with and without the stimuli) are always larger and closer to 750 msec. than the means for rhythmic response to the light (with and without the stimuli), (c) all standard deviations for the experimental groups were smaller than those of the control group and (d) all standard deviations for the Vibar scores were smaller than they were for the light scores.

The original statistical plan was to run a two-factor analysis of variance with "groups" (treatment and control) as the between factor and "mode" (light and Vibar) as the within factor. However, Figure 1 suggests that the treatment and control groups might not have similar variances; Table 1 reveals that the variances were significantly smaller in the treatment group than they were in the control group. This lack of homogeneity of variances between the treatment and control groups suggests drawbacks to the original statistical plan of comparing means. A non-parametric technique that permits an appropriate analyis of the data is SAS's PROC RANK program wherein all scores are first ranked and then precisely the same analysis (i.e., a two-factor analysis of variance with "groups" as the between factor and "mode" as the within factor) is made. Table 2 presents the results of this analysis for the "with" stimuli comparisons; Table 3 presents the results of this analysis for the "without" stimuli comparisons.

The differences between the treatment and control groups were found to be significant ($\underline{P}$'s = .05 and .10 for the "with" and "without" condition, respectively). These tables also reveal that the combined treatment and control groups' scores with the Vibar stimulus were significantly better than were their scores with the light stimulus ($\underline{P}$'s = .01 and .10, respectively).

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*One 5th grade treatment subject sustained a severe ankle sprain (outside of class) subsequent to the pretest but prior to the start of training; since she missed most of the training periods, she was dropped from the study and was not post-tested. One 5th grade control subject was an outlier (average standard deviation of -1.950 for the 4 tests/conditions). One 6th grade treatment subject was an outlier (average standard deviation of -2.700 for the 4 tests/conditions). Both of these subjects were dropped from the data analyses. One further treatment subject was also an outlier for both visual tests; however, this subject's scores were considered good for the Vibar test so he was retained as a subject.

Figure 1

Means/Standard Deviations

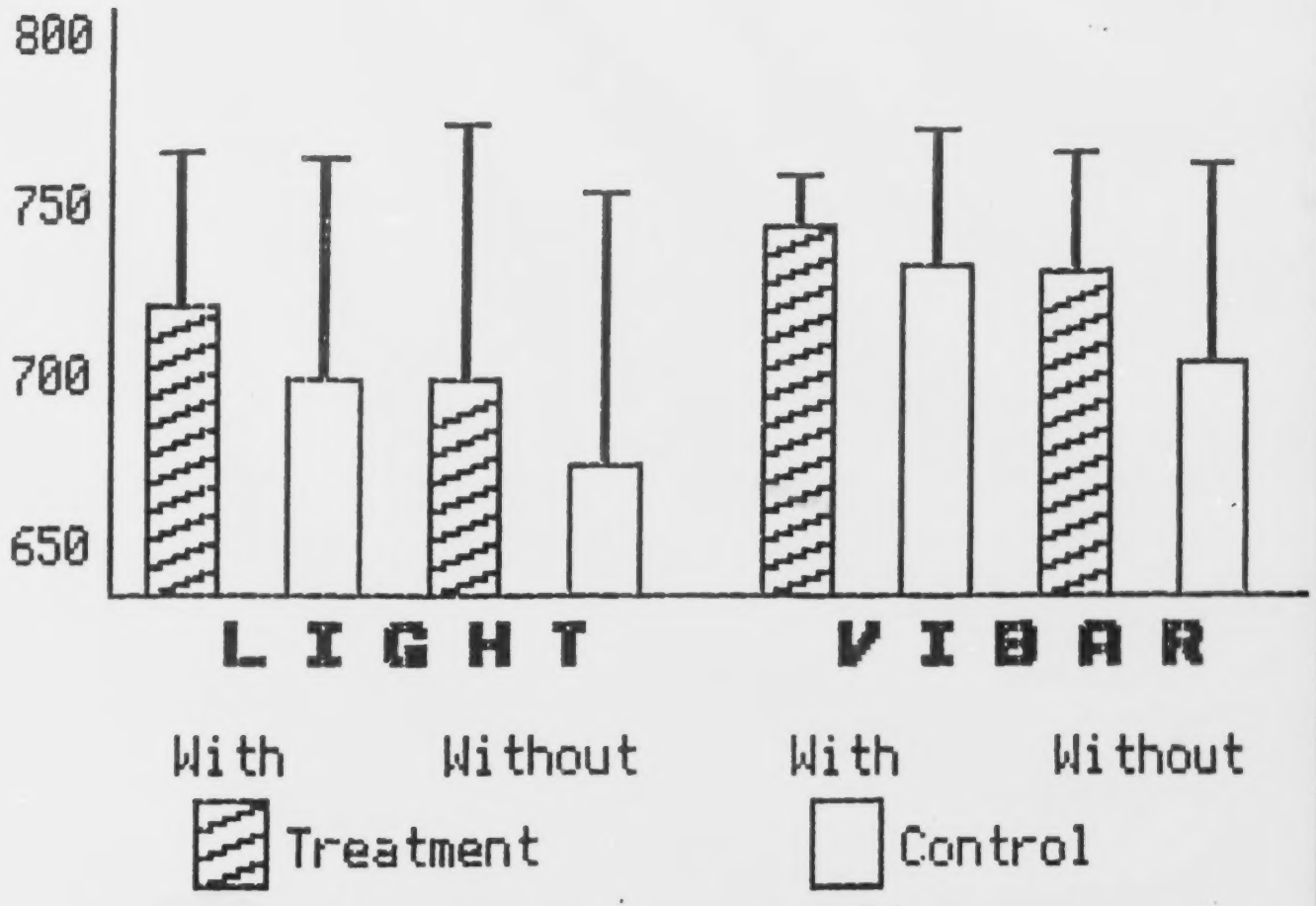

TABLE 1

Control/Treatment/Variance Ratios

Test/Condition		F	P
With:	Light	2.0156	.0568
	Vibar	7.8959	.0000
W/O:	Light	1.1328	.3889
	Vibar	2.8994	.0075

TABLE 2

ANALYSIS OF VARIANCE (WITH STIMULI)

SOURCE	DF	SS	MS	F	P
BETWEEN Ss (42)					
Groups	1	3,507	3,507	5.59	0.05
Error b	41	25,692	627		
WITHIN Ss (43)					
Mode	1	3,934	3,934	8.18	0.01
Groups*Mode	1	172	172	0.36	
Error w	41	19,729	481		
TOTAL	85	53,034			

TABLE 3

ANALYSIS OF VARIANCE (WITHOUT STIMULI)

SOURCE		DF	SS	MS	F	P
BETWEEN Ss	(42)					
Groups		1	2,771	2,771	3.01	0.10
Error b		41	37,796	922		
WITHIN Ss	(43)					
Mode		1	882	882	3.13	0.10
Groups*Mode		1	5	5	0.02	
Error w		41	11,546	282		
TOTAL		85	53,000			

DISCUSSION OF RESULTS--YEAR TWO

The efficaciousness of the treatment in improving rhythmicity is supported at least for the "with stimulus" condition. The fact that the post-testing upon which the analysis was based was conducted 11 weeks subsequent to the rhythmicity training program suggests that the effect is more than temporary. Demographic data on the subjects furnished by TSD could be considered as further support of the efficacy of the treatment program.* Figures 2 and 3 provide information on the subjects' Speech Perception and Pure-Tone Hearing scores, respectively. (The latter data were collected by TSD personnel in September and October, 1984; the training program was implemented in January 1985 and completed in March, 1985. The post-testing was conducted in May, 1985.)

In the subject population auditory speech perception scores ranged from 8 to 88 (a larger number indicates a better score).** Figure 2 indicates that the control group had higher auditory speech perception scores than the treatment group; these differences were significant ($\underline{P} = .05$). Pure tone hearing scores ranged from 60.5 to 110 (a smaller number indicates better hearing). If a subject did not respond to any of the three Hz test levels at 110 db of the test, he/she was given a score of 111 for purposes of this investigation; therefore any error would be in giving too conservative of an estimate. Figure 3 indicates that the control group had better scores on the Pure-Tone Hearing test than did the treatment group; however, this difference was not found to be significant. If the speech perception and the pure tone hearing scores could affect and/or be related to rhythmicity performance, it would appear that the control group may have had more pre-training rhythmic potential.

Both experimental and control groups performed significantly better in response to the Vibar stimuli than the visual stimuli. This was somewhat surprising since the hearing impaired are often considered as being exceptionally visually orientated. This research suggests that, for at least some situations, whether they be in education, learning a trade, working on an assembly line, etc., the vibrotactile modality should be considered as a viable means of facilitating motor performance.

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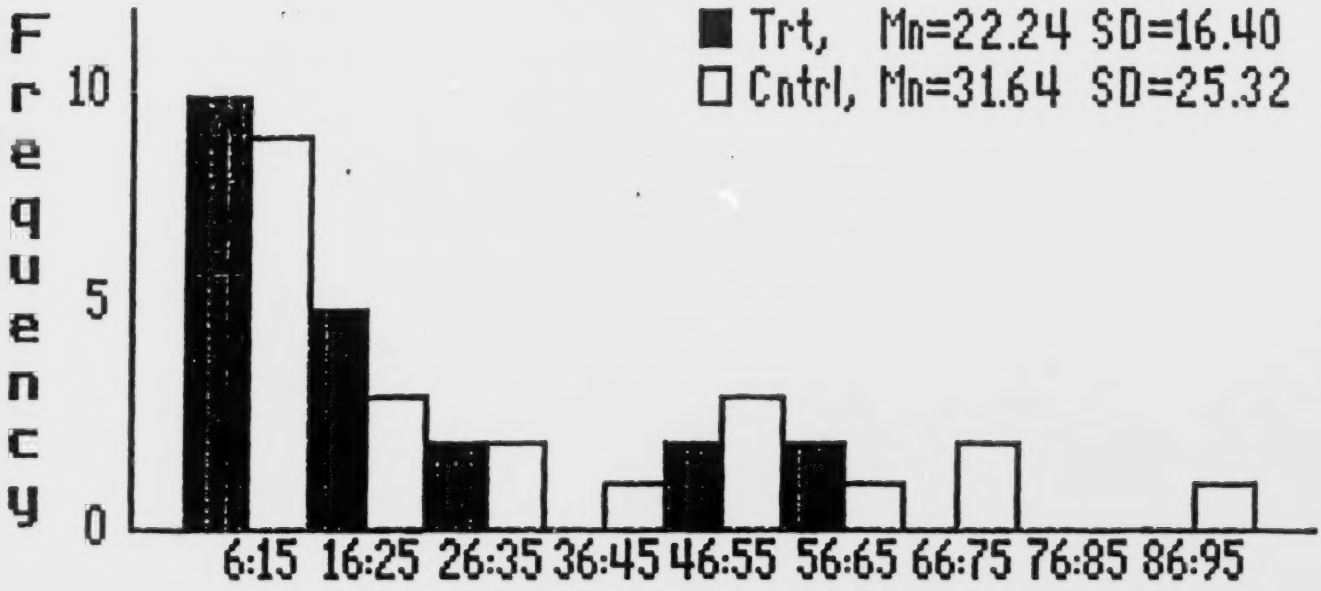
*It was originally planned to determine if the rhythmicity training impacted upon speech perception scores because (a) some of the training used was verbotonal in nature and (b) verbotonal training positively affects speech perception (Asp, 1985). A pre-post treatment analysis of speech perception was impossible because of the software problems in the rhythmicity testing equipment. Although the treatment would not be expected to affect Pure-Tone hearing scores, intuitively subject scores on this variable would be expected to relate to rhythmicity.

**The outlier that was dropped from the experimental group had a speech perception score of 1.

Figure 2

Speech Perception

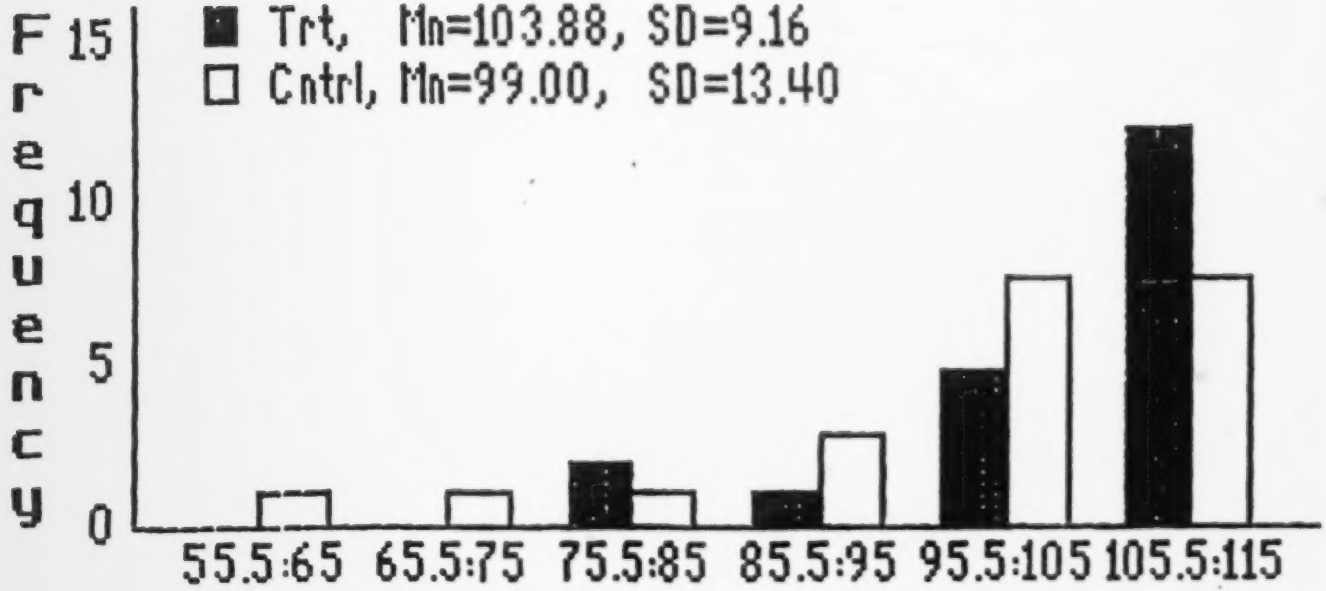


Speech Perception Scores

(Higher scores indicate better speech perception)

Figure 3

Pure-Tone Hearing



Pure-Tone Hearing Scores

(Higher scores indicate poorer hearing)

CONCLUSIONS

1. This research supports the efficacy of a rhythmicity training as used in this investigation. Other parameters could be investigated in conjunction with this; for example, does rhythmicity training improve speech or other processes?

2. In the rhythmic test conditions presented, the hearing impaired children performed better to (and following) the vibrotactile stimuli than the visual stimuli. The strong support seen for this modality of stimulus presentation suggests that vibrotactile stimuli should be further explored relative to its efficacy in facilitating motor performance of the hearing impaired in other settings (e.g., in training and/or work setting environments).

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AN INTERDISCIPLINARY APPROACH TO TRAINING THE ARRHYTHMIC CHILD (ADDENDUM TO FINAL PROJECT REPORT)

by
Wendell Liemohn, Ph.D.
School of HPER
College of Education
The University of Tennessee
Knoxville

Final Project Report (dtd September, 1985, Addendum dtd January, 1986)

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Appendix A

Dissemination of the curriculum manual titled RIGORS & RHYTHMS:

1. Direct Mailings:
   A. 1983 Membership roster, National Consortium on Physical Education and Recreation for the Handicapped. This included 67 copies mailed to the following states/universities:
      Alabama: Jacksonville State University
      Arkansas: University of Arkansas
      California: San Diego State University, Los Angeles State University, San Francisco State University
      Colorado: Images In Motion, Boulder
      Connecticut: Universty of Connecticut
      District of Columbia: Special Olympics,
      Florida: University of South Florida
      Georgia: University of Georgia
      Illinois: Western Illinois University, University of Illinois, Northern Illinois University, Southern Illinois University
      Iowa: University of Northern Iowa, University of Iowa
      Indiana: Indiana University
      Kentucky: University of Kentucky
      Louisiana: Louisana State University
      Maryland; University of Maryland
      Missouri: Southwest Missouri State University, University of Missouri
      Nebraska: Kearney State College
      New Mexico: University of New Mexico
      New Jersey: Montclair State College
      New York: Manhattan College, SUNY--Brockport, New York University
      North Carolina: Appalachia State University, University of North Carolina--Greensboro, East Carolina University, North Carolina Central University
      Ohio: Kent State University, Bowling Green State University, Wright State University, Ohio Department of Education, Ohio State University, Cleveland State University
      Oklahoma: University of Tulsa
      Oregon: Oregon State University
      Pennsylvania: Penn State University, Temple University
      Tennessee: Middle Tennessee State University
      Texas: Texas Christian University, Texas Womans Universty
      Vermont: University of Vermont
      Virginia: University of Virginia, Virginia Tech Universty, George Mason University
      Washington: YMCA USA, Longview, Washington State University
      Wisconsin: University of Wisconsin--Lacrosse
   B. The 1985 membership roster has just been received; 45 additional copies will be mailed to those members not on the 1983 membership roster.

2. 21 requests for copies (all have been filled) received from:
   David Reams, Editor, ABLE BODIES.
   David Beaver, Editor, PALAESTRA.

Dale Ulrich, Section Editor, ADAPTED PHYSICAL ACTIVITIES QUARTERLY
Kendall Demonstration School, Washington, D.C.
Elementary Physical Education Teacher, Denver, CO
Adapted Physical Education Teacher, Houston, TX
Elementary Physical Education Teacher, Arlington, TX
Elementary Physical Education Teacher, Ft Worth, TX
South Carolina School for the Deaf, Spartanburg, SC (13 copies were requested from this institution in addition to the number received at the CAID Convention)

3. Dissemination in conjunction with presentations:

a) Ninety nine copies were disseminated in conjunction with two presentations made by the PI at the Convention of American Instructors of the Deaf/Conference of Educational Administrators Serving the Deaf, St. Augustine, June, 1985. The institutions and/or individuals receiving one or more copies included:

California State University, Department of Special Education
Collier Center for Communication Disorders, Dallas, TX
Orange County Public Schools, Orlando, FL
Utah School for the Deaf, Salt Lake City
Carron Park High SChool, Baltimore, MD
Arkansas School for the Deaf, Little Rock, AR
Arizona School for the Deaf, Tucson, AR
South Carolina School for the Deaf, Spartanburg, SC
Lexington School, Jackson Heights, NY
Florida School for the Deaf, St. Augustine
Lafayette Parish Schools, Lafayette, LA
Minnesota School for the Deaf, Faribault, MN

Additionally approximately 50 copies were made available to those institutions/individuals interested (who did not attend either presentation) in the exhibits room; an accounting of this distribution was not practical.

b) Fifteen copies (all that were in-hand) were disseminated to speech and hearing scientists and practitioners who attended a presentation by the PI at the Fifth Annual American Verbotonal Conference, Knoxville, TN, August, 1985.

c) Twelve copies (all that were in-hand) were disseminated to the therapeutic recreation attendees at presentation by the PI at the Smokey Mountain Recreation Consortium, Pigeon Forge, TN, September, 1985. Recipients represented:

South Carolina Department of Mental Health
South Carolina Parks, Recreation and Tourism
Middle Tennessee State University
Mars Hill College
Patricia Neal Rehabilitation Center, Knoxville
The Spastics Society, London
British Sports Association for the Disabled, London
Parks and Recreation Department, Jonesborough, TN
Parthenon Pavilion, Nashville, TN

Tennessee Rehabilitation Center, Smyrna, TN

4. 61 other mailings:
Advocate for Physical Education and Recreation, Special Education Programs, Department of Education, Washington, DC (50 copies)
Idaho State University
Los Angeles County Education Center
Loughborough University
University of Iowa
University of Puerto Rico--Bayamon Gardens
University of Jyvaskyla
Secretary, Central America and Caribbean Commission of Physical Education, Sports and Recreation for the Handicapped.
Tennessee State University
Tennessee Tech University
Tusculum College, Greeneville, TN
Middle Tennessee State University

5. Other distributions (82 copies):
The 19 schools providing subjects for Year ONE (i.e., Knoxville City, Knox and Anderson County schools) and Year TWO (i.e., Tennessee School for the Deaf) also received copies. Copies were given to Special Education and Resource Room teachers, music teachers and physical education teachers, as well as the administrators who facilitated this endeavor.

6. As additional requests are received, copies will be furnished at no cost to the requestor until all copies have been expended (i.e., 500).

Appendix C

Dissemination of Research:

1. Gatlinburg Conference on Research and Theory in Mental Retardation and Developmental Disabilities. Title of presentation: The role of rhythmicity in motor skill. (3/8/84) (Abstracted in the Proceedings of the 17th Annual Gatlinburg Conference.)

2. American Alliance for Health, Physical Education, Recreation and Dance Convention, Anaheim, CA. Part of a symposia titled "Motor Skill in Special Populations" organized by the PI. Title of presenation: Rhythmicity and timing in special populations. (3/30/84)

3. National Consortium on Physical Education and Recreation for the Handicapped, College Park, MD. Title of presentation: Rhythmicity in handicapped children. (8/10/84)

4. Gatlinburg Conference on Research and Theory in Mental Retardation and Developmental Disabilities. Title of presentation: Timing and rhythlmicity in the hearing impaired. (3/6/85) (Abstracted in the Proceedings of the 18th Annual Gatlinburg Conference.)

6. Convention of American Instructors of the Deaf/Conference of Education Administrators of Schools for the Deaf, St. Augustine, FL. Title of presentation: Rhythmicity training in the hearing impaired. (6/24 and 6/26/85)

7. Fifth Annual American Verbotonal Conference, Knoxville, TN. Title of presentation: Rhythm training activities with deaf students. (8/2/85)

8. Projected presentations:
   Fifth International Symposium on Adapted Physical Activity, Toronto. Title of presentation: Rhythmicity training in the hearing impaired. (10/4/85)

   Alexander Graham Bell Assoication for the Deaf 1986 International Convention, Chicago. Title of presentation submitted: Rhythmic tapping response to vibro-tactual and visual stimuli: training effects. (7/86)

   American Alliance for Health, Physical Education, Recreation and Dance, Southern District Convention, Winston-Salem, NC. Title of projected submission: The effect of a rhythmic training program on the rhythmicity skills of the deaf (2/86)
   Annual Convention of the American Alliance for Health, Physical Education, Recreation and Dance, Cincinatti., 1986. Title of projected submission: Sensory cues and motor performance in the hearing impaired..

9. Projected publications:

At this venture this is somewhat presumptuous; however, articles will be submitted to journals whose readership includes: verbotonal speech therapists/researchers, deaf educators/researchers, rehabilitation educators/researchers, motor learners, adapted physical educators. It is expected that project consultants from disciplines other than that of the PI will be co-authors for some submissions.

Appendix D

Introduction to Rhythmic Video-Tape Evaluation Format:

Two PE classes at Tennessee School for the Deaf recently participated in a project in which we endeavored to improve their rhythmicity skills. Rhythmicity was measured by a computer and its complimentary hardware that were designed for this project. Because there were originally some hardware as well as software problems, it was desirable to conduct a second rhythmicity evaluation; that is the purpose of this vidio-tape.

You are being asked to follow a protocol to evaluate these same TSD subjects as they perform calisthenics in their PE classes. You will see three classes perform these exercises; the first one on the tape will only be used to determine inter and intra-rater reliability. You will note that there are two students assisting the exercise leader; only select students will be evaluated in this class.

In the next two classes you will see the experimental and the control subjects; however, you will not know who belongs to each group. You will evaluate all of these children, except for a few who did not participate in the research (e.g., Ss with cerebral palsy). The latter individuals will be identified.

The evaluation will be divided into two sections. The first part of the evaluation (Form-A) deals with whether or not the subject is in cadence (rhythm) with a beep (audible signal) that has been dubbed on the video tape. The number of audible signals will vary with each exercise; evaluators will be given instructions on the criteria for judgement and you will practice on this until you meet criterion. The second part of the evaluation process involves completing a Likert-type scale (Form-B); it provides the opportunity to qualitatively evaluate each subject's performance on each exercise. For both Form A and B it is imperative that the evaluator(s) be as careful as possible in following the criteria in making their judgements.

Form A: Rhythm Evalution

EXERCISE 1. Trunk Twists

This exercise is counted and divided into two parts (2 audible signals). To begin the exercise the legs are in the straddle position and arms are held horizontally. (The children will have 5 warm-ups first; you will begin scoring on the 6th repetition concurrent with the first beat.)

Beat 1. Left shoulder crossing midline of the body
Beat 2. Right shoulder crossing midline of the body

5 reps--2 Beat Exercise: 1 2 (10 audible beeps)
Y N Y N

EXERCISE 2. Toe Touches

This exercise is counted and divided into 4 parts but there is only 2 audible signals. To begin the exercise the legs are separated slightly wider than shoulder width and arms are held horizontal. The children will have 5 warm-ups first; you begin scoring on the first audible beep.

Beat 1. Right hand to left toe
Beat 2. Hands come to middle position and are clapped (no audible signal and no scoring--this was going to be scored originally but it was too difficult to attain satisfactory reliability)
Beat 3. Left hand to right toe
Beat 4. Hands come to middle position and are clapped (again, no scoring on the hand clap)

5 reps--4 Beat Exercise: 1 2 3 4 (score 10 audible beeps)
Y N Y N Y N Y N

EXERCISE 3. Jumping Jacks

This exercise is counted and divided into two distinct parts (two audible signals). The children will have 5 warm-ups first; begin scoring with the first audible beep.

Beat 1. Hands should touch (or be approximately over the head). At the same time the subject's legs should be in straddle position.
Beat 2. The subjects arms should touch the lateral portions of his/her thighs. At the same time the legs should come together and the body should approximate the military "at-attention" position.

5 reps--2 Beat Exercise: 1 2 (10 audible beeps)
Y N Y N

Form B: Rhythmic Evaluation

Grade _____ , Ss# _____

Immediately after viewing a subject's performance of an exercise, answer the following questions regarding the execution of the exercise (check appropriate column):

	Seldom	Sometimes	Always
1. Student stays on cadence but not in synch with group.	___	___	___
2. The subject is fully completing the exercise as described by the performance criteria.	___	___	___
3. The subject shows balance while completing the prescribed repetitions.	___	___	___
4. The subject seems directed by those around him/her and may be exhibiting rhythm patterns of others. (should only be of concern if subject is off rhythm)	___	___	___
5. The subject, although completing the exercise, seems to be off cadence for the most part but on his/her individual rhythmic pattern, or cadence.	___	___	___

EXERCISE 1--Trunk Twists Grade _____

Ss/Trial	1	2	3	4	5	6	7	8	9	10
A1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
A2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
A3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
A4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
B1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
B2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
B3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
B4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
C1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
C2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
C3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
C4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
D1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
D2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
D3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
D4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
E1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
E2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N

Ss/Trial	1		2		3		4		5		6		7		8		9		10	
E3	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
E4	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F1	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1				3		4		5		6		7		8		9		10	
F2	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F3	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F4	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N

EXERCISE 2--Toe Touches Grade _____

Ss/Trial	1	2	3	4	5	6	7	8	9	10
A1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
A2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
A3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
A4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
B1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
B2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
B3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
B4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
C1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
C2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
C3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
C4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
D1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
D2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
D3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
D4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
E1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
Ss/Trial	1	2	3	4	5	6	7	8	9	10
E2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N

Ss/Trial	1		2		3		4		5		6		7		8		9		10	
E3	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
E4	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F1	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F2	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F3	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F4	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N

EXERCISE 3--Jumping Jacks Grade _____

Ss/Trial	1	2	3	4	5	6	7	8	9	10
A1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
A2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
A3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
A4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
B1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
B2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
B3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
B4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
C1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
C2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
C3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
C4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
D1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
D2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
D3	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
D4	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
E1	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N
E2	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N

Ss/Trial	1		2		3		4		5		6		7		8		9		10	
E3	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
E4	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F1	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F2	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F3	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ss/Trial	1		2		3		4		5		6		7		8		9		10	
F4	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N